AN APPARATUS FOR THE STUDY OF COMPARATIVE EFFECTS OF CONSTANT VERSUS VARIABLE TEMPERATURES ON THE SPEED OF INSECT METABOLISM[1]

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Introduction

Among students of insects, studies of the relative effect of variable and constant temperatures has led to almost diametrically opposed conclusions. Furthermore, the integration of extensive studies of the effect of constant temperatures with extensive studies upon the effect of variable temperatures, which a knowledge of this relationship would make possible, might very well lead to the better interpretation of the effects of variable temperatures recorded by the United States Weather Bureau for so many years.

With the idea of arriving at an understanding of this relationship between the effects of variable and constant temperatures the writer has constructed a piece of apparatus which is described in the following report.

Principles Involved in the Apparatus

Temperature Control

Obviously to get anywhere with a study of this sort the temperatures employed, whether variable or constant, must be under a control of the student and obviously also the range which they cover must be within the active cycle of the insect or insects studied. In this apparatus this control has been provided by employing an electric refrigerator capable of holding temperatures within a swing of four or five degrees down to a point as low as thirty-two degrees F. In this refrigerator are placed two insulated boxes each of which is fitted with a heating element under thermostatic control. By setting these thermostats the

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falling temperature within the box is arrested and held at the desired working point. The thermostat employed for this purpose in the constant temperature box is a simple bimetallic plate and a firmly set contact point, while the thermostat employed in the variable temperature box consists of a bimetallic plate and a constantly moving contact element. This contact element is under control and follows the revolution of a clock wheel which is completed every twenty-four hours. By this means for approximately twelve hours the contact point is moving away from the bimetallic plate and for the succeeding twelve hours the contact point is constantly moving toward the bimetallic plate. This arrangement produces a minimum and a maximum temperature every twenty-four hours, which by varying the position of the bimetallic plate may be made to swing between different highs and lows.

In the apparatus diagramed as Plate II battery controlled relays are employed because the thermostatic points are sufficiently delicate to be burned by the 110-volt 60-cycle current available.

Moisture Control

Since it has been shown by various workers that atmospheric moisture has a decided bearing upon insect metabolism, especially when dealing with certain species, it is obvious that that should be rendered constant. Fortunately it has been shown that the amount of water given off to an air stream bubbling slowly through a saturated solution of common salt is practically the same whether the temperature is ninety or fifty degrees F. or at any point between.

All, therefore, that is necessary to control atmospheric moisture and eliminate it as a variable factor is to dry the air by bubbling it slowly through concentrated sulphuric acid and raise its moisture content to about 73 per cent. by bubbling it slowly through a saturated equeous solution of common salt.

Gas-Constitution-of-the-Air Control

Since it has been shown by various workers that a reasonable supply of fresh air is necessary to the maximum activity of insects under experimentation this factor is provided by passing

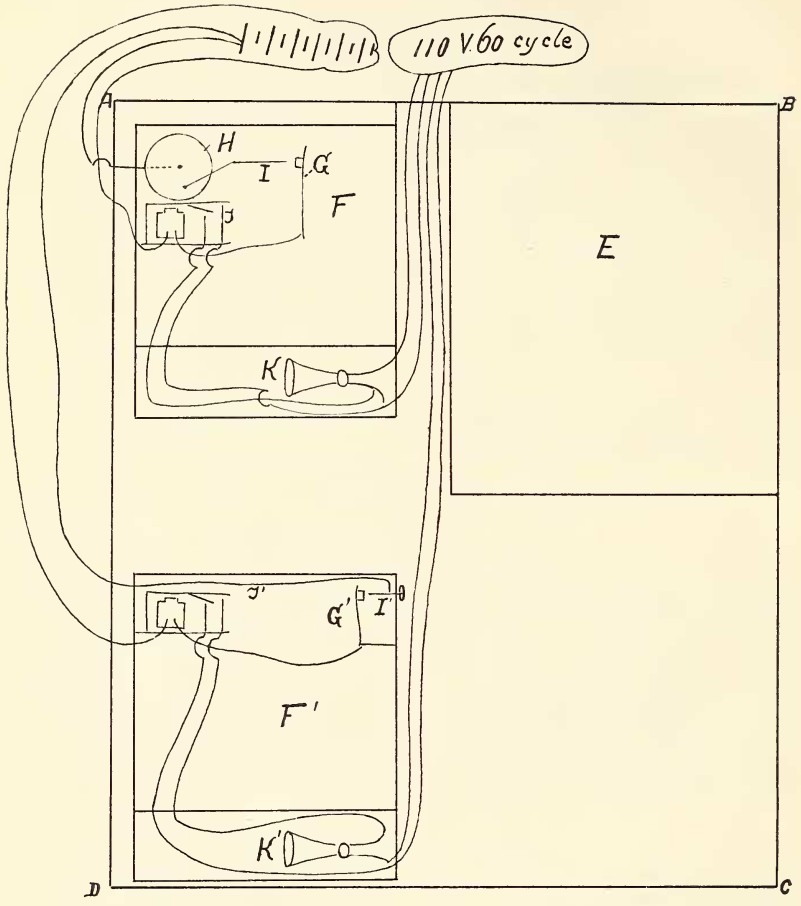
air, conditioned as to temperature and atmospheric moisture, through the containers holding the insects at the rate of about one liter every ten minutes.

Light Control

Since it has been shown by various workers that if the light is allowed to vary, the insects under experimentation are influenced and have their metabolism modified by it, it is, of course, necessary to control that factor. This control has been accomplished by shutting out the light. The heating units produce a red glow, which, however, in view of the fact that they are located in this apparatus in the lower chamber and shut off from the one which contained the insects by more than a quarter of an inch of asbestos board, would seem unlikely to introduce a serious variable. Of course it would be possible to introduce in the place of the asbestos board material definitely known to screen out red and infra-red rays.

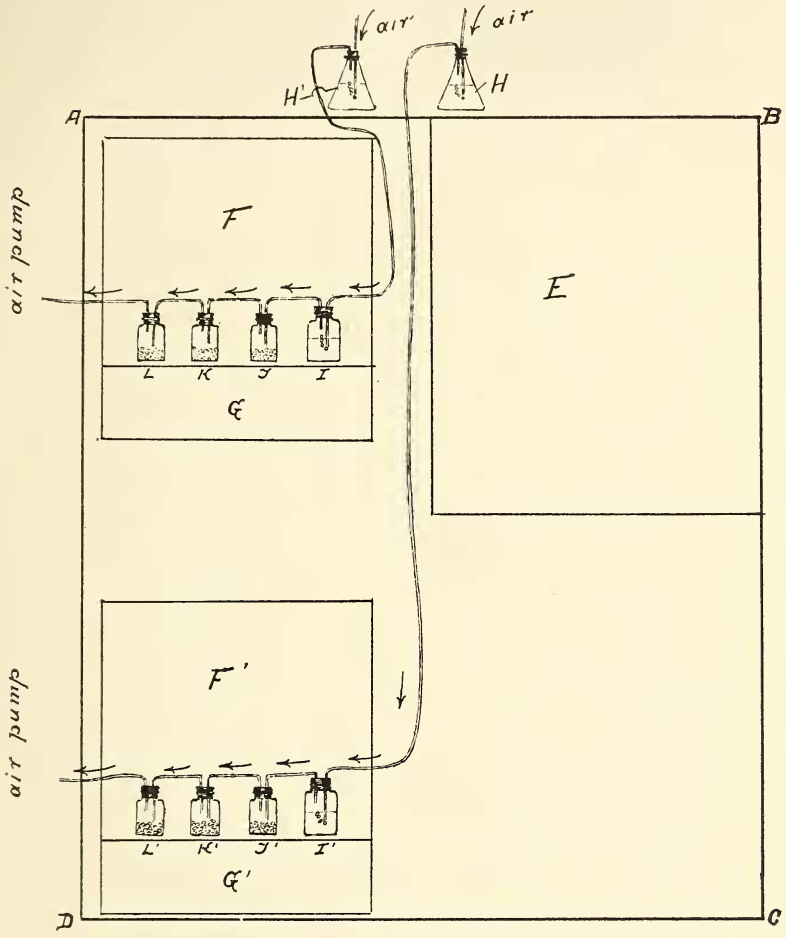
CONCLUSION

Thus it seems that the variables other than temperature have been reduced to zero or at least to a negligible point permitting direct experimentation with a controlled constant versus a controlled variable temperature. The procedure of the writer in carrying on these experiments has been to run the constant temperature box at the average of the variable and to adjust the range of the variable on the basis of the average range of active temperatures for the insect with which he is working.



Temperature Control

A B C D, electric refrigerator; E, cooling element; F, insect chamber, variable temperature; F′, insect chamber, constant temperature; G G′, thermostat plate; H, clock work wheel (complete revolution each 24 hours); I I′, thermostatic contact point; J J′, relays; K K′, heating chambers.



Moisture Control

A B C D, electric refrigerator; E, cooling element; F, insect chamber, variable temperature; F′, insect chamber, constant temperature; G G′, heating chambers; H H′, sulfuric acid bubblers; I I′, saturated solution of sodium chloride bubblers; J K L and J′ K′ L′, insect containers.